Inquiry on Federal Water Policy
Research Paper # 3

MUNICIPAL WATERWORKS AND WASTEWATER SYSTEMS

by

J.W. MacLaren, P.Eng.

January 1985
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THE INQUIRY ON FEDERAL WATER POLICY

The Inquiry on Federal Water Policy was appointed by the federal Minister of the Environment in January of 1984 under the authority of the Canada Water Act. The members were Peter H. Pearse, chairman; Françoise Bertrand, member; and James W. MacLaren, member. The Inquiry was required by its terms of reference to review matters of water policy and management within federal jurisdiction and to make recommendations.

This document is one of a series of research papers commissioned by the Inquiry to advance its investigation. The views and conclusions expressed in the research papers are those of the authors. The fact that the author of this paper is himself a member of the Inquiry does not commit the Inquiry as a whole to any views expressed herein.

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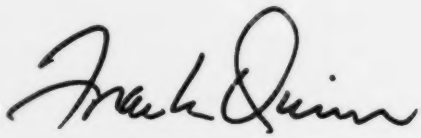

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Abstract

Persistent pollutants, especially toxic compounds, threaten some of the 2500 municipal water supplies in Canada and provision must be made to protect these supplies including the provision of treatment or improved treatment where necessary.

Many Canadian municipalities do not yet treat their waste water. More than 8,000,000 people reside in municipalities in Canada where no sewage treatment has yet been provided to protect the receiving waters and their other uses. Significant improvement in this situation is required.

Substantial volumes of wastes reach the receiving waters of Canada from the overflows of combined sewers and storm sewers of municipalities during storm periods. These overflows are capable of better management for receiving water protection.

Finally the state of water and sewage works systems in Canada is deteriorating, especially in the portions buried below city streets and significant rehabilitation programs are required to sustain these aging systems whose current replacement value is estimated at over $100 billion.

All of the foregoing suggest the need for the Federal Government with the Provinces to develop programs to catalyze municipal spending in these important areas.

Résumé

Des polluants de nature persistante, spécialement des composés toxiques, menacent les sources d'approvisionnement en eau de certaines des 2500 municipalités du Canada et des mesures doivent être prises pour protéger ces approvisionnements; ces mesures comprennent entre autre la mise en place d'usines de traitement de l'eau ou une amélioration du niveau de traitement des usines déjà en place.

Beaucoup de municipalités canadiennes ne traitent toujours pas leurs eaux usées. Plus de 8,000,000 de Canadiens résident dans des municipalités où aucun traitement des eaux d'égouts afin de protéger les cours d'eau récepteurs et leurs autres utilisations n'est fait. Une amélioration significative de cette situation est requise.

Des quantités importantes de déchets atteignent les cours d'eau récepteurs du Canada par suite de débordements des réseaux d'égouts combinés ou pluviaux des municipalités au cours des périodes de fortes pluies. Une meilleure gestion de ces débordements est possible.

Finalement, l'état des équipements en eau canadiens, particulièrement la partie enfouie sous les rues, se détériore et d'importants programmes de réhabilitation sont nécessaires afin de soutenir ces systèmes vieillissants dont la valeur de remplacement actuelle est estimée à $100 milliards.

Tout ce qui précède suggère un besoin pour le gouvernement fédéral, en collaboration avec les provinces, de développer des programmes afin de catalyser les déboursés municipaux dans ces domaines importants.

INQUIRY ON FEDERAL WATER POLICY

MUNICIPAL WATERWORKS AND WASTEWATER SYSTEMS

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MUNICIPAL WATERWORKS AND WASTEWATER SYSTEMS

1. IMPORTANCE

The provision of a safe and adequate water supply for Canadians has long been a goal of our governments through the efforts of our Health and Public Works departments at all three levels of jurisdiction - federal, provincial and municipal.

Today governments throughout the world are committed in the Declaration of Alma Alta (1978) and with the guidance of the World Health Organization to attain the global goal of "Health for all by the year 2000". No small part of the declaration states that "primary health care includes at least an adequate supply of safe water and basic sanitation".(1)

To achieve that declaration, there must also be a commitment to adequately collect and treat wastewaters created from water use so that their impurities will not significantly pollute the water regime to the detriment of the public health, other uses and the total ecosystem.

Municipal water supply and wastewater systems are essential to the functioning of the social and economic pulse of our modern community, not only from a health point of view but to permit the servicing of a large sector of our commercial and industrial activity and to provide protection against fire and flooding.

Statistics revealed in later sections of this report give evidence to the fact that many Canadians, particularly native people living in the smaller and more remote areas of Canada, have drinking water and sanitation levels that are considerably lower than the national average and in some instances below the objectives of the World Health Organization.

TABLE 1

WATER SUPPLY AND WASTEWATER SYSTEMS .... EXTENT OF SERVICES
RÉSEAUX DE DISTRIBUTION D'EAU ET DE COLLECTE DES EAUX USÉES .... PORTÉE DES SERVICES

	Alberta	B.C. C.-B.	Manitoba	N.B. N.-B.	NFLD T.-N.	N.W.T. T.N.O.	N.S. N.-É.	Ontario	P.E.I. I.P.É.	Québec	Saskatchewan	Yukon	Canada
a) Number of communities surveyed Nombre de municipalités inventoriées	209	135	260	84	296	50	103	423	23	1 481	140	8	3 212
b) Total population surveyed Population totale inventoriée	1 664 480	2 003 640	835 792	409 661	509 118	43 953	531 174	7 580 074	57 387	6 686 604	579 895	21 888	20 923 866
i) No. of communities with distribution network Nombre de municipalités ayant un réseau de distribution	194	132	168	62	195	35	82	401	6	1 053	140	6	2 474
ii) Population served by distribution network Population desservie par les réseaux de distribution	1 633 417	1 979 590	807 282	369 004	450 110	37 653	481 912	7 519 386	44 437	6 351 862	579 895	21 238	20 275 786
iii) No. of communities with water treatment Nombre de municipalités dont l'eau est traitée	180	87	123	23	147	36	65	396	1	556	135	6	1 755
iv) Population served by water treatment Population disposant d'eau traitée	1 439 992	1 130 897	783 712	227 045	366 379	37 827	437 795	6 853 696	21 000	5 360 729	566 576	18 950	17 244 598
i) No. of communities with sewers Nombre de municipalités ayant un réseau d'assainissement	205	120	138	80	113	37	98	335	23	805	140	8	2 102
ii) Population served by sewers Population desservie par les réseaux d'assainissement	1 539 442	1 645 361	794 601	374 616	323 649	40 277	447 331	6 579 956	58 171	5 476 853	573 186	19 260	17 872 705
iii) No. of communities with sewage treatment plants Nombre de municipalités dont les eaux usées sont épurées	205	109	132	73	42	10	76	325	22	242	139	7	1 382
iv) Population served by sewage treatment Population dont les eaux usées sont épurées	1 486 744	1 572 606	794 601	188 154	58 190	23 091	114 566	6 372 964	54 363	414 322	572 285	18 860	11 671 033

Source: Environment Canada. EPS. National Inventory of Municipal Waterworks and Wastewater Systems in Canada, 1981 (with September 25, 1984 update). Supply and Services Canada.

2. HISTORY

Municipal water supply systems in Canada were introduced with the creation of the Loch Lomond Water Supply for the City of Saint John, New Brunswick in 1837[2] followed by the provision of municipal water services in Toronto (1841), Halifax (1848), and Montreal (1857). By 1860, six municipal water supplies were functioning and increased to 235 by the turn of the century. By the end of World War I, this had increased to 500 and more than 1,500[2] by the end of World War II. Today, more than 2,500 communities in Canada have water supply systems serving more than 20,000,000 Canadians.

During this period awareness grew of the fact that water acted as a carrier for typhoid, cholera, bacilliary dysentery, giardiasis, hepatitis type A, and a variety of other diarrheal diseases of bacterial, amoebic and viral origin[1]. Since most supplies were of the surface variety they were very much exposed to these forms of bacterial and viral infection. As society became aware of the links between pure water supply and public health, water treatment came into use commencing with the construction of the Jewel Filter for the City of Fredericton in 1906. By 1920, 42 percent of all municipal water supplies were treated by filtration and 82 percent were protected by chlorination. Today, sophisticated systems are now employed for filtration, taste and odour control, and contaminant removal[3]. Some major supplies, however, such as Victoria, Greater Vancouver, Winnipeg, and Saint John, N.B. still exist as impounded surface supplies from protected watersheds employing chlorination alone.

Sewerage and wastewater treatment followed the provision of

water supply systems but at a slower pace. Initially, cess pools and septic tanks provided for the wastewaters but the growing use of water and increasing industrialization created the need for sewerage to carry away the polluted waters from the areas of development to the adjacent water bodies. This prevented the creation of disease breeding areas within urban development but assumed that dilution was the solution to pollution.

Systems of sewerage were commenced im many municipalities in the 1860's but treatment did not become common practice until the years after World War II. Toronto instigated primary treatment of a crude variety in 1910 but it was the late twenties before these programs started to accelerate and only in the early 1950's did sewage treatment become a major area of municipal spending in Canada.

Today, more than 2,000 of the 3,300 communities in Canada have sewers serving more than 17,800,000 people. Of these about 1,400 have treatment plants of some fashion serving about 12,000,000 Canadians (3).

3. MUNICIPAL WATER AND WASTEWATER DEMAND STATISTICS

According to a survey undertaken for Health and Welfare Canada in 1977-78, the average consumption of tap water in Canada was 1.34 litres per person per day. In contrast the average demand for municipal water supply systems was almost 500 litres per day per capita (1).

Environment Canada operates a computer based data management system known as "MUNDAT" which is employed to consolidate basic information on municipal waterworks and wastewater systems provided by the various federal, provincial and territorial agencies that participate in the

TABLE 2

WATER USE BY USER CATEGORY*
CONSOMMATION D'EAU PAR CATEGORIE D'UTILISATEUR*

Province-Territory Province-Territoire	Residential % Domestique	Commercial % Commercial	Industrial % Industriel	Institutional % Institutions Publiques	Other % Autre
Alberta	42	32	4	2	20
British Columbia Colombie-Britannique	58	19	19	0	4
Manitoba	46	14	17	1	22
New Brunswick Nouveau-Brunswick	45	7	33	9	6
Newfoundland Terre-Neuve	74	7	13	2	4
Northwest Territories Territoires du Nord-Ouest	80	9	0	9	2
Nova Scotia Nouvelle-Ecosse	33	6	35	9	17
Ontario	41	8	19	4	28
Prince Edward Island Ile-du-Prince-Edouard	36	9	43	4	8
Quebec	60	8	16	4	12
Saskatchewan	36	24	11	3	26
Yukon	61	13	3	12	11
Canada	51	11	19	4	15

*Data are weighted on basis of flow
*Donnees ponderees d'apres le debit

Source: Environment Canada, EPS. National Inventory of Municipal Waterworks and Wastewater Systems in Canada, 1981 (with September 25, 1984 update). Supply and Services Canada.

annual survey of related data[3].

This information is summarized in a publication known as "National Inventory of Municipal Waterworks and Wastewater Systems in Canada"[3] the latest version of which is 1981. Reduced funding prevented the publication of the 1983 version. Table 1 from that publication provides details on the number of systems and population served by waterworks and sewerage in Canada in 1981.

In Table 2, entitled "Water Use by User Category", figures indicate that 51 percent of municipal supplies are used for residential purposes, 11 percent for commercial, 19 percent for industrial, and 19 percent for public purposes or unaccounted for. Although these figures vary across Canada by jurisdiction, the variable appears to be caused by the relative degree of industrialization of the municipality.

In the Canada Water Year Book of 1975, figures were listed [2] showing per capita consumption in municipal water systems varying from a low of 358 litres per capita per day in Manitoba to a high of 614 litres per capita per day in Quebec.

While actual Canadian data are unavailable on the number of municipal systems that meter the supplies to consumers there is considerable evidence to indicate that metered pricing of water reduces consumption. The reduction tends to be concentrated in external uses to the home (lawn watering etc.) and not in the domestic or in-house use.

Table 3 [4A] provides data to confirm this taken from statistics of the Ontario Department of Municipal Affairs - 1967 which indicate that in municipalities of less that 10,000 a mean per capita consumption of 64 gpcd was realistic with the consumption increasing with the size of the municipality. A further reference, Table 4, indicates that municipal consumption in the United States showed reducing per capita consumption with increases in metering as well as a general increase in consumption with size of municipality. Another reference [4A] indicates increasing

TABLE 3

Summary of Municipal Water Works Statistics
for Typical Group of Smaller Ontario Municipalities

	POPULATION RANGE							
	0 - 1000		1000-2000		2000-5000		5000-10,00	
	UNM*	MET*	UNM	MET	UNM	MET	UNM	ME
Number Reporting	12	3	12	3	8	8	-	1
Average Consumption- gpcd	60	48	66	54	66	71	-	8
Extreme Variations in Consumption - gpcd	100-23	98-41	116-25	66-29	76-53	93-48	-	107
Average Number Persons per Consumer	3.6	3.5	3.5	3.0	4.2	3.0	-	3.
Mileage of main per 100 persons served	5.4	5.7	3.8	6.5	2.5	3.9	-	3.
Number of hydrants per 1000 persons served	26.5	30	32	40	18	27.5	-	22.

*UNM - unmetered
MET - metered

Source: Canada, Atlantic Development Board. Water Resources, Newfoundland, Vol. 3B. September 1968.

TABLE 4

Municipal Water Consumption
in U.-S. gallons/cap/day

Percent Metered	Population (1000's)					Total Population
	5 - 10	10-25	25-50	50-100	100 +	
0-50	152	158	174	162	142	145
50-95	103	108	109	114	129	121
95-99	102	100	102	102	124	116
99+	99	107	107	100	114	109
Total Population*	108	112	111	108	125	110

*Weighted Average

Source: Canada, Atlantic Development Board. Water Resources, Newfoundland, Vol. 3B. September 1968.

per capita use of water with increasing disposable income.

Actually, experience has indicated that per capita water consumption varies with climate, standard of living, extent of sewerage, extent of commercialization and industrial development, cost of water, quality of water, system pressure, extent of metering and system management(4).

One significant variable in calculating water consumption has been the amount of unaccounted for water which represents water for firefighting, street flushing, lawn watering in parks, construction site water, hydrant flushing and most significantly main leakage.

This varies widely from system to system with 15 percent or less of total consumption considered good control and in excess of 25 percent poor control.

Similar data exists from the MUNDAT program for wastewater systems. Here the quantity of municipal wastewater generated equals the municipal water use less that amount of water not reaching the sewers through consumptive use plus water, generally subsurface, which infiltrates into the sewers.

Water not reaching the sewers includes part of the leakage losses in the water distribution system, some of the publicly used water, part of the water used for lawn sprinkling and water depleted and evaporated in various laundries and industrial systems.

Infiltration into sewers varies with the nature of the soil in which the sewers are installed, the height of the groundwater table relative to the sewer as well as the standard of construction of the sewer system. Infiltration rates vary from 0.05 to 0.50 cubic meters per kilometre of sewer per millimetre of diameter per day with 0.15 cubic meters being considered an acceptable limit. Extraneous inflow to sewers through man-

hole tops and boot leg connections can materially increase flows during periods of precipitation.

Canadian figures for per capita wastewater flows are available through the MUNDAT program but to date have not been accumulated to produce regional averages. Normally 60 to 70 percent of the total water supplied becomes wastewater and with a reasonable allowance for infiltration, the per capita wastewater flows tend to equal or slightly exceed per capita water consumption.

The rate of water consumption changes with the seasons, with the days of the week and with the hours of the day. There is a major seasonal peak in Canadian waterworks systems during the heat of the summer when large volumes of water are drawn for lawn watering, refreshment, swimming pools and air conditioners. There is a daily peak in consumption close to noon and an extreme minimum in the early hours of the morning. Generally the maximum day of consumption exceeds the average from 1.2 to 2.0:1 with an average of 1.5:1 while the maximum hour consumption exceeds the average hour from 2.0 to 3.0:1 with an average 2.3:1 (4). Firefighting flows impose another peak on waterworks systems that relate to density and type of land use as well as municipal size.

Peak flows in wastewater systems vary with water consumption but fluctations are generally less severe since not all water reaches the sewer, sewer flow is generally by gravity and therefore slow to respond to change and infiltration of groundwater tends to be steady through the day. Smaller communities generally experience higher peak rates than larger one.

On these facts, the maximum daily flow of a sewerage system approximates twice average and maximum hourly flow 1.5 times the average flow of the maximum day (4).

A number of Canadian sewerage systems are comprised of combined sewers in which both stormwater and sewage are provided for in the same pipe. In these instances peak flows during rainfall periods exceed average flow by many times and only limited treatment can be provided the combined flows under such circumstances. This results in the discharge of combined sewer overflows to the nearest watercourses during periods of rainfall causing pollution of these waters.

Many communities have a separate system of sewers in which sanitary sewers are provided for the wastewater and storm sewers for roof and street runoff from rainfall. The latter sewers discharge directly to local watercourses during rainfall periods and although less polluting in their discharge than combined sewers they do carry considerable pollution from street and land surfaces including domestic animal pollution and fertilizer and pesticides. Sanitary sewers should be free of stormwater but illicit connections, manhole leakage, etc., frequently provide an unwanted inflow that is gauged to average 7 to 10 litres per capita per day.

Demand management of water use in municipal waterworks systems through metered pricing, lawn watering regulations and plumbing codes restrictions can have not only a material effect in reducing water consumption and waste water production but in reducing the required capacity of waterworks and wastewater systems thereby reducing both their capital and operating costs.

4. FINANCIAL STATISTICS RELATING TO WATER AND WASTEWATER SYSTEMS

It is important to obtain a measure of the size of the waterworks and wastewater infrastructure in respect of a number of fiscal parameters. Statistics Canada gathers considerable data on "Water and Sewage" that has been analysed by the Federation of Associations on the Canadian Environment (FACE) and presented in its brief to the Inquiry [5]. Un-

fortunatly the Statistics Canada data do not appear consistent in several areas so that the conclusions must be modified to reflect that current inadequacy.

However, it is estimated that based on past statistics and present day dollar value approximately $1.3 billion dollars was spent on municipal waterworks in Canada in 1984 and about $1.1 billion on wastewater systems. These represent the expenditure of capital for new or replaced works and not the value of system operation and maintenance. The figure has risen steadily from a value of about $800 million combined in 1973. The majority of this expenditure was made by municipal governments with some provincial and federal assistance as later described.

Approximately 7.5 percent of the total expenditure of local governments is devoted to waterworks, wastewater systems and stormwater systems. Presumably this represents the annual cost of operations and maintenance plus the annual fixed charges for principal and interest on capital debt. This translates into an annual per capita expenditure of $55 for waterworks and $33 for sewage works and drainage(5).

It is not clear from the Statistics Canada information as to the percent of these expenditures that are raised on direct users charges as distinct from a general levy against the taxable assessment of the municipalities. However, a study on "Canada's Urban Infrastructure" prepared for the Federation of Canadian Municipalities by its Technical Committee on Urban Infrastructure revealed that user fees bear most of the funding for operation, replacement and rehabilitation of water distribution systems (86 percent), water treatment (83 percent), sewage treatment (82 percent) and sewage collection (54 percent)(6).

In the definition by Statistics Canada of total value added (this is Census Value Added and is a measure of net output i.e., the gross output

less those purchased inputs which have been embodied in the value of the product) the value of $2.5 billion is assigned the Water Pollution Control Manufacturing and Primary Industries in 1982. Apparently about 450 to 500 companies or divisions of companies contributed to this figure and represented about 45,000 to 50,000 jobs.

In addition, based on the number of water supply and sewage works systems in operation in Canada - approximately 4,500 combined, it is reasonable to expect that more than 50,000 persons are directly employed in their dayto-day operation, mostly as members of the Canadian Union of Public Employees.

Several studies have attempted to estimate the value of the waterworks and wastewater systems in Canada but no estimate of the total Canadian infrastructure has been developed.

In Atlantic Canada, it is estimated that the total value of water utility plants (not wastewater) in 1984 was between $300 and $600 million for the 1,247,000 persons served by piped central system. This is a book value, however, of which $450 million for new works was spent in the past 12 years.(7)

This represents an average per capita book value of $440. It is stated in that report that "we are considering an industry with an operating budget of $40 million per annum exclusive of capital repayment requirements. This in itself requires over $24 million annually to be provided by the utilities from their revenue from the sale of water in addition to payments by provincial governments on a major portion of outstanding debt".

That report also makes significant note of the fact that there are 265,000 persons in Atlantic Canada with piped running water generally served from their own private well which it is estimated has a "present worth" of approximately $400 million.

A report prepared for the Ontario Ministry of the Environment in 1983 on the rehabilitation of water distribution and sewerage systems for Ontario municipalities[8] estimated that the current per capita replacement value (1983) of water distribution in Ontario ws $2,350 and for sewage was $2,065 (exludes provision for stormwater). Generally estimates of system value accord 80 percent of total value to distribution and 20 percent to treatment and supply of water and 70 percent of sewerage and 30 percent for treatment of sewage. This suggests a replacement value of approximately $3,000 per capita for each facility including total works.

Translated into total Canadian figures this could represent a national replacement value for waterworks of $62 billion and for wastewater systems of $47.5 billion. The protection of investment of this consequence is therefore an item of extreme national importance in a fiscal sense as well as a health and economic activity sense.

5. INFRASTRUCTURE NEEDS

The foregoing analyses indicate the need for continued improvement and rehabilitation in the servicing of Canada's urban areas for the protection of the public health and the maintenance of economic growth. The major areas of required attention appear to be concentrated in:

a) provision of treatment or improvements in treatment for drinking water quality due to the threat of increasing pollution, especially contaminants of a persistent nature. This can include increased watershed protection to impounded supplies such as in Saint John, N.B., or Winnipeg, Manitoba or protection to underground aquifers in ground water supplies.

b) provision of or increased efficiency in treatment for municipal wastewaters to protect the various uses of the related receiving bodies.

c) reduction in the pollutional impact of combined sewer and stormsewer overflows on the adjacent receiving bodies to protect the various uses of those waters especially in respect of the recreational values that are offered to the urban population.

d) assistance in initiating and/or maintaining a positive program of rehabilitation of the wter distribution and sewerage systems of urban areas to ensure their continued life and service.

e) assistance in establishing training programs for water treatment and sewage treatment operators in municipal systems and in establishing a national program in certifying and maintaining the qualifications of these operators.

f) establishing a system for testing, rating and qualifying equipment, materials and chemicals utilized in water and wastewater infra-structure so as to ensure bona-fide products of a consistent nature suitable to public health service including wastewater control.

g) regulating and controlling bottled water and point of use water qualities.

h) producing nationally co-ordinated infrastructure data.

a) <u>Provision or Improvement in Municipal Water Treatment</u>

The MUNDAT data indicate that 2,474 communities representing more than 20

million Canadians have municipal distribution systems for water including 1,755 that have some form of water treatment other than chlorination serving about 17 million Canadians. Indeed there is an inconsistency in the standards of water quality found in municipal finished water supplies across our country and in the reporting of the quality of these supplies. The need for consistent quality data reporting and for maintaining minimal drinking water standards is painfully obvious. The quality of these supplies is highly variable.

The quality of the untreated water serving these systems today is too often being reduced due to:

1) the impact of increased organic pollution
2) the increase of direct contaminants of a persistent nature such as toxic chemicals, heavy metals, etc.
3) encroachment of land use activities on impounded and previously pristine water and on underground aquifers.
4) effect of long range transport of pollutants especially acid rain on system pH as well as quality.

All of these impacts reduce the quality of water for municipal supply and threaten the health of the consumers. Despite extensive programs to protect watersheds and eliminate the discharge of polluting substances that have been undertaken by all levels of government in recent years, surface and now too frequently groundwater are sometimes contaminated to the extent of exceeding the capacity of existing treatment systems or where such have not previously existed requiring same or otherwise improved watershed or underground aquifer protection.

Canadian water supply systems according to the statistics of the World Health Organization have virtually eliminated sickness from bacterial and viral sources so that they are as safe as any in the world. There are

still threats from giardiasis and occasional threats of viral diarrhoea presumably from system failure[1].

However, the continuing control of microbial pathogens in municipal water supplies is today overshadowed by the threat of highly sophisticated synthetic organic compounds that are the direct or indirect result of chemical manufacture. As well heavy metal pollutants such as lead, cadium, arsenic and their derivatives continue to threaten the food chain and the ultimate consumer through his drinking water.

There is insufficient knowledge to establish no effect or threshhold levels for the vast majority of these compounds. Many however have been shown to be carcinogenic, teranogenic, mutagenic or immune suppresants at some level to some species.

Although it is true that these contaminents are in relatively low concentration in most drinking waters including the impact of the trihalomethanes formed through disinfection of water supplies by chlorine, we are in fact operating a large scale human experiment and we are gambling that no ill effects will occur but there is genuine concern that at least in some areas increased water treatment of a more sophisticated nature may be required to maintain these contaminants at safe levels in the drinking water.

A large number of municipal surface supplies are provided with screening, flocculation, sedimentation, rapid sand filtration and chlorination plus taste and odour control. More recently some plants have been developed with screening, flocculation, dual media high rate filtration and chlorination. Synthetic organic contaminants as well as heavy metals in low concentration may not be sufficiently removed by these processes although studies are currently being carried out by the Ontario Ministry of the Environment to confirm this. In any case some plants such as the

Buffalo Pond treatment plant serving Regina-Moose Jaw are already constructing the addition of ground activated carbon facilities as tertiary treatment to remove threats from organic and toxic contaminants.

Other plants that are not capable of holding the concentration of trihalomethane in the finished water following chlorination to safe levels may eventually be required to provide ozonation or chloramination as a substitute for chlorination.

Also many current supplies which to date have been found acceptable in quality and require only disinfection through chlorination, may now be exhibiting quality parameters that justify the initiation of treatment such as filtration, pH adjustment, improved protection, etc. This is especially true of a large number of smaller municipal supplies across Canada.

Indeed the reduction of the alkalinity in water supplies through the impact of acid precipitation threatens to not only create corrosive system conditions but to increase the presence of heavy metal in the water supply source through acidification and leaching of natural occurring minerals in the watershed.

Finally, groundwater, the source of supply for many medium to small community water supply systems across Canada is no longer as safe from contamination and as free from the need of treatment as once regarded. Complex organic compounds have penetrated these aquifers from industrial and municipal landfills and from leaking structures creating difficulties contamination problems in some instances.

b) Provision or Improvement in Municipal Wastewater Treatment

The MUNDAT data is updated through 1983 indicate that more than 2,100 communities in Canada are provided by central system of sanitary sewers serving almost 18,000,000 Canadians but with only 1,382 of these systems provided with some form of sewage treatment serving only about 12,000,000 people. Therefore, a considerable number of Canadian municipalities are still without sewers and many are without sewage treatment. Indeed the 1977 House Needs Analyses of the Canada Department of Indian Affairs and Northern Development report that 55 percent of the native people have no sewage disposal available to them. One province, Quebec, has recently undertaken a very ambitious program of assisting municipalities financially to install sewage treatment so that where in 1981, less than 9 percent of the urban population was served by sewerage systems that included sewage treatment, most should have such facilities by 1990.

However, a large number of existing plants are not capable of producing an effluent quality that any longer adequately protects their receiving waters. Continue urban growth has increased pressure on the assimilative capacity of our streams, rivers and lakes to absorb the residual organic loadings from wastewater plants. Also the impact of certain synthetic organic compounds of a persistent nature and low level concentrations of heavy metals cannot be modified by assimulative capacity but simply exist or build up to levels that threaten the ecosystem and the safety of other uses of these receiving waters.

Improved treatment from primary to secondary levels and from secondary to best available technology is in many instances now needed. These additional levels in some cases will require expenditures in capital and operating accounts that equal or exceed the cost of the provision of the original treatment under present day replacement values.

c) Reduction in the Pollutional Impact of Combined Sewer and Storm Overflows

The urban runoff discharging to local receiving waters as overflows from combined sewerage systems or direct discharges from stormsewer systems pose a threat to effective water quality management that represent a technical and economic frustration that no government has adequately solved.

When the sewer system of the older central areas of our urban areas were first designed, it was normal practice to provide for the combined flow of stormwater and wastewater in the same sewer and to discharge it untreated to the receiving waters. With increased awareness of health hazards, intercepting sewers were built and the sanitary flows conveyed to a treatment plant where the objectional characteristics of these flows were reduced to acceptable levels prior to discharge. The intercepting sewers were frequently designed not only to provide for peak hour sanitary sewage flows of 1.5 to 2 times average but to accommodate three times the average wastewater or dry weather flow so that some small portion of stormwater entering the combined sewer system during rainfall could be contained and treated. However, the major portion of the combined flows which exceeded dry weather flow by 50 to 100 times was discharged during rainfall periods directly to the receiving waters at combined sewer overflow outlets.

Problems of stream pollution experienced as a result of these combined sewer overflows and treatment plant bypasses during storm events lead to the provision of separate sewer systems in which wastewaters were provided for in sanitary sewers and stormwaters were collected separately in stormsewers.

Thus in the new areas of most cities, there are only separate sewer systems. However, a large number of studies conducted within the last 25

years have revealed that the continued pollution of receiving waters is partly attributable to urban stormwater runoff. A common guideline is that the 5-day Biochemical Oxygen Demand of stormwater may be similar to that of sanitary sewage following secondary treatment, while the level of suspended solids in stormwater is equal to that found in raw sewage.

Therefore, pollution from storm runoff whether from combined sewer overflows or direct stormwater discharge can be substantially greater than the discharge of treated effluent from treatment plants and has a more significant impact on the receiving waters than the continuous source.

The very high cost of separating sewers in the older areas of our cities can really, therefore, only be justified if those systems are inadequate to prevent flooding during rainfall of the properties served. Otherwise since such separation only partially alleviates water pollution, a re-evaluation of the combined sewer outfall problem in conjunction with stormwater discharges has been necessary.

The trend today is toward total management of urban water resource systems in which inter-relationships between problems of sanitary sewage, storm runoff, treatment plant operation and receiving water condition are considered to avoid the prohibitive cost of independent solution.

Therefore, municipalities are today considering and/or implementing provision of a number of inter-related solutions to quality control for stormwater overflows.

1) the provision of a separate system of road sewers in which the original combined sewer is employed for sanitary sewage collection and a new sewer is constructed with provision for road and surface runoff and the runoff from new development. Since a major cost of sewer separation is the reconnection and/or provision of sewer

laterals, this scheme postpones that need until redevelopment justifies it. It does therefore take almost 50 years or more to effect full separation and its benefits still can only be justified where the present combined sewer system provides inadequate capacity to prevent flooding of properties during rainfall periods.

2) the provision of a "real time" control system to fully utilize the capacity of the system of sewers and any additional "off-line" storage that could be provided to balance the hydraulic loading at the treatment plant. The reasons for this provision can be summarized as:

   a) a multiplicity of overflow points exist
   b) no priority sequence of overflows from various districts exists to minimize environmental harm and hazards.
   c) the full hydraulic capacities of each section of the sewer system are not realized
   d) the whole sewer system is not used in relation to the spatial and intensity patterns of rainfall and runoff in various areas of the system.

Usually, the initial steps towards real time control are the installation of a number of remotely operated gates within the combined and intercepting systems. The operation of these gates allows flows to be diverted to local storage or treatment units or into a large sewer or interceptors in order to balance water levels and flows throughout the system thus -

- maximizing utilization of intercepting sewer capacity to carry combined sewage to the wastewater treatment plant
- maximize utilization of intercepting and off line storage capacity
- provide priority in the intercepting sewers to flows from the most polluting areas

- integrate and optimize use of combined sewer overflow storage or treatment facilities.

3) the provision of an improved interception rate through increased intercepting sewer capacity. A practical maximum fixed intercepting sewer rate is probably 6 times dry weather flow average. The results of such provision have indicated that it probably is not very effective in controlling pollution during the major storm events but on an annual average basis this increased interception would provide a significant reduction in overflow-related pollution since a number of smaller storms and the first polluting flush of larger events would be contained.

4) the provision of overflow storage to reduce the number of annual stormwater overflows from storm sewers as well as combined sewer systems. Off-line stormwater storage tanks could store the surplus flow and permit the peak overflows to be reduced in number and time with the stored flow later treated at the treatment facilities.

5) the provision of combined sewer overflow and stormwater treatment facilities through increased treatment of at least of a primary nature as the treatment plant, stormwater sedimentation tanks with or without chlorination, stormwater outlet collection for centralized chlorination, etc. All of these systems can be considered in conjunction with the previous four alternatives.

d) <u>Assistance in Initiating and/or Maintaining Continous Programs of Rehabilitation of Water Distribution and Sewerage Systems</u>

While considerable effort and funds have been directed toward extension and expansion of waterworks and sewage works systems over the past few decades, little thought has been given to replacing them as they event-

tually wear out. While user and abuser charges cover the cost of fixed and operating expenses, they too frequently do not provide funds for rehabilitation and eventual replacement. Furthermore, repair efforts are frequently crisis-oriented rather than preventative. Budgets tend to put renovation and replacement considerations beyond their timeframe.

Compounding this basic problem of maintaining infrastructure has been the higher inflation rates of the 1970's creating growing costs in system operation. At the same time, society underwent a period when a growing array of new services designed to improve the quality of life were provided by governments putting further pressure on the tax dollar. Finally, interest rates soared making municipal funding difficult, if not painful.

All of this together with a world recession has considerably reduced the ability of municipalities to maintain or in many cases initiate an adequate rehabilitation program for extending the useful lives of water-works and sewage works whose ages extend in some cases to 125 years but on a weighted basis across Canada to probably 40 years(8). Especially this is true of the underground portions of these systems including the service connections. Surface plant is generally more readily maintained and shows visible evidence of the need for rehabilitation but underground plant tends to be "out of sight - out of mind".

As a result emergency repairs for water distribution systems have increased from 17 to 30 per 100 km of main during the past 15 years, unaccounted for water has been on the increase primarily from leaking mains and service pressure has been reduced due to main capacity loss through tuberculation(6).

Similarly sewer failures have increased from 6 to 17 per 100 km of sewer over the past 15 years, infiltration and inflow rates have increased and

sewer capacity has been reduced by these extraneous flows as well as their impact on increased sewage treatment costs.(6).

These conditions suggest in one study that the capital expenditure necessary to upgrade water distribution and sewerage over the next 10 years will be $76.00 and $97.00 per capita respectively on an annual basis(6).

On the other hand, another study(8) suggests that the current replacement values of water distribution and sewerage systems are $2,350 and $2,065 (1983) per capita respectively. Adequate annual programs of rehabilitation if instituted now could sustain these systems for at least 100 years of useful life at an annual cost of $15 to $25 per capita. Only about one third of that amount is currently being spent for these purposes(8).

The worst problem areas are in the small to medium sized towns which have not undergone major urban renewal nor experienced significant suburban expansion. Here the problems are a combination of undersized mains and pipe deterioration(7).

In the light of the value of these systems (probably $75 billion at current replacement value for underground plant) and the importance of their physical integrity to the health, social and economic well being of the country, it is necessary to ensure that each is made the subject of an engineering and financial plan that will:

* ensure that they continue to distribute safe, reliable and efficient water supplies at adequate pressure and similarly provide sewerage that will safely and adequately pipe away wastewater to treatment facilities that provide receiving water protection.

* protect the substantial investment of underground plant through systematic repair and rehabilitation.

* avoid wastage of resources, undue wear on the systems and unnecessary emergency repairs and interruption of service.

* defer expenditure on new works through full and efficient use of existing plant.

* schedule funds for renovation and replacement of facilities to avoid system failure and massive expenditures in the future.

The key to such a plan is continuity of effort and a systematic, economic and practicable approach. The systems will wear out and they will fail; funding must be allocated for repair and replacement and be logically distributed over time. It is emphasized that the plan is not for building or extending systems, it is directed toward repair, renovation and replacement of existing watermains, valves, fittings, hydrants and service connections and of existing sewerage facilities including manholes, catch basins and sewer laterals.

The emphasis of such a plan will shift with time. Initially most effort will be directed to identifying problems and rectifying a backlog of deficiencies. As major problems are corrected more emphasis will be placed on preventative maintenance to preserve the system and prolong its useful life. Replacement and renewal will become significant activities as the systems age and funds accumulate for renewal.

The major need therefore is for the Federal Government to create a public awareness of the importance of good system husbandry and to mount an inventory and system examination program to set priorities for a regularized program of system replenishment for continued life.

e) Assistance in Establishing Training Programs and Certification of Water Treatment and Sewage Treatment Operators

The satisfactory operation of water supply and treatment works and of sewage treatment plants is essential. Without satisfactory operation these plants will not fulfill the value of their considerable investment nor protect the consumer or adjacent water users.

Their efficient operation is generally a matter of municipal responsibility under provincial regulation but it is important that an adequate cadre of trained personnel to service this field, approximately 50,000 jobs, be available nationally with recognized and comparable accreditation.

Some training efforts have been made in all provinces usually by provincial agencies such as Environment and Health. Alberta has moved to certification and Ontario operates annual training schools.

Initial efforts tended to be directed to wastewater systems including chlorination workshops also directly applicable to water treatment plants. Courses have been developed through Environment Canada and the Federation of Associations on the Canadian Environment (FACE).

More recently, again with the assistance of FACE the federal and provincial governments funded the development of courses for waterworks operators which benefit materially from training programs produced by the American Water Works Association.

However, there is a need to standardize this procedure at the national level and therefore the current program of Health and Welfare Canada to develop in concert with the provinces standardized training programs and certification levels for operators should be a commitment toward mandatory certification as with stationary engineers for boiler plant operation.

Without this, the provision of safe drinking water and wastewater effluent standards cannot be adequately achieved nor can a sufficient number of trained operators be made available for the long term needs.

f) Establishment of System for Testing, Rating and Qualifying Equipment, Materials and Chemicals Utilized for Water and Wastewater Service

Products used in the treatment of raw water as well as for the distribution of finished water for public consumption can themselves be a significant source of contamination (1). These include both substances and equipment used in the purification process as well as the equipment, piping and plumbing used in distribution systems. Also the purchaser should be assured of the consistent quality of these materials to protect him from inferior production that could reduce serviceability and long system life.

Although the public health implications are not as obvious in products used in the collection and treatment of wastewaters in public systems, the assurance of quality and consistent standard is equally necessary.

In the United States, the American Water Works Association have for some years set standard specifications for most chemicals and equipment used in water supply. Although conformation to these standards is not necessary for those manufacturers producing for the industry they are generally followed. These specifications are used widely in Canada in purchasing waterworks materials and supplies.

No similar system exists for materials furnished in the wastewater industry.

At the present time there are no purity standards enforced for water treatment chemicals in Canada and no indication of the pipe types that are considered as acceptable on a legalized basis for waterworks service. A "seal of approval" operation whereby manufacturers of these products could seek

an assessment of their suitability for use in municipal water supply systems was operated until 1980 by Health and Welfare Canada but was abandoned for fiscal reasons leaving Canadian manufacturers disadvantaged to U.S. manufacturers who operate on EPA approval.

Similar conditions exist in the wastewater field and it is very clear that the federal government with the support of the provinces should consider enforcing the use of the Canadian Standards Association procedures in testing, approving and rating chemicals, materials and equipment for use in water supply and wastewater collection and treatment in Canada.

g) Regulating and Controlling Bottled Water and Point of Use Equipment

There has been an increasing use of bottled water in Canada as Canadians become concerned over water quality issues and the possibility of a less than safe drinking water from municipal supplies. Although this situation apparently suffers from sensationalism it does mean that the federal government under the Food and Drug Act should act now to assure consumers that bottled waters are safe to drink.

Bottled water has a definite shelf life and in some tests have been found less adequate than public drinking water.

Definite regulation on the production, quality and distribution of bottled drinking water should be available.

Similarly much publicity has been attached to the benefits of using home treatment filters as a cure for less than adequate drinking water supplied from municipal systems.

However, it is not clear that these systems have been rated and tested for the protection that they are advocated to provide. Also, if they are not adequately serviced they can be the subject of bacterial build up providing counter-productive service.

As in the case of products used in water supply systems, these units should require a CSA style approval from Health and Welfare Canada to be available for sale in Canada and consumers should be advised of their weaknesses including the possibility that they may not be sold without the provision of an on-going service contract.

h) Producing Nationally Co-ordinated Infrastructure Data

In 1974, the provincial and federal governments in co-operation with the Federation of Associations on the Canadian Environment (FACE) undertook a major inventory of municipal waterworks and wastewater systems in Canada. The results of that work were published as the "National Inventory of Municipal Waterworks and Wastewater Systems in Canada - 1975" which has since been updated in 1978 and 1981 (3). No 1984 edition was published due to lack of federal funding.

Actually, the MUNDAT program of Environment Canada now collates more data than the inventory publication indicates, especially on aspects such as details on operating personnel, cost of operation, ect. There is, however, a major omission that relates to detailed information on the water distribution and sewerage systems (underground plant). Since these facilities represent the major value in both systems and are the areas of concern in rehabilitation and maintenance of service, data should be available to properly assess the extent of these works, their condition and progress on their rehabilitation.

Also, little still exists on items such as raw and finished water quality, on actual loading conditions for various treatment systems and on water rates.

There is, therefore a need to produce data nationally of a more comprehensive and standardized nature to permit comparative analyses. This would permit the value of the waterworks and wastewater system industry to be assessed, its condition and efficiency to be determined and national programs to be established for improving service in both the provision of drinking water and the protection of receiving waters.

The Canadian Council of Resource and Environmental Ministers (CCREM) provides an excellent vehicle in co-operation with FACE and its member associations to develop this more comprehensive and standardized approach.

6. FEDERAL ASSISTANCE PROVIDED TO MUNICIPAL INFRASTRUCTURE IN WATER AND SEWAGE WORKS

6.1 General

In assessing the importance and needs of municipal waterworks and wastewater systems to the people of Canada, it is important to recognize the history of the federal role in building and maintaining these works in support of the municipalities through the provinces.

Exactly when the federal government commenced any initial interest in municipal infrastructure of this nature is difficult to determine. It is suggested (2) that the severe economic effects of the depression of the early 1930's undermined the financial integrity of many Canadian municipalities and several provinces as well as the country as a whole. As a result the federal government followed the lead of the United States in undertaking massive public works spending to create jobs and stir the economy. Some of Canada's water supply and pollution control facilities such as the North End Sewage Treatment Plant and the intercepting sewer system of the Greater Winnipeg Sanitary District were constricted as relief projects in conjunction with the provinces in the late 30's.

Later however, despite massive moves of our population to urban areas specially during the industrial activity of the World War II and the economic boom that followed it, the senior governments tended to ignore municipal needs in water supply and wastewater control. Howeover the 1950 report of the International Joint Commission on the pollution of the Great Lakes from Sault Ste. Marie to the Niagara River brought home the serious issue of water pollution and the need for the Great Lake states and the Province of Ontario to install adequate wastewater control facilities in their urban areas. This need slowly spread across our country and senior government interest in water quality control commenced to concentrate through the formation of organizations such as the Ontario Water Resources Commission (1956) and the New Brunswick Water Authority (1958).

Meantime the federal role in water was still primarily patterned after its agriculturally related programs under the Prairie Farm Rehabilitation Act in drought proofing the prairies and under the Maritime Marshlands Rehabilitation Act in recovering salt marshes from the sea with the construction of aboisdeaus.

In 1953, the passage of Canada Water Conservation Assistance Act permitted the federal government to enter into agreements with any province for contributions by Canada in respect of the cost of projects for the construction of dams and other works for the conservation and control of water resources in a province. Although this program did not bear directly on municipal water and wastewater infrastructure it did provide for the period 1953 to 1970 when it was superceded by the Canada Water Act for the construction of dams in Ontario and British Columbia that impounded water for multiple purposes including municipal water supply and low flow dilution for pollution control. In most cases funding was provided on a division of 37 1/2 percent federal, 37 1/2 percent provincial and 25 percent municipal or local.

6.2 Municipal Infrastructure Program (1961 - 1978)

In 1961, however, the Government of Canada under the Diefenbaker regime passed an amendment to the National Housing Act as Part VIII in which it required Central Mortgage and Housing Corporation to assist in the elimination or prevention of water and soil pollution "through making a loan to any province, municipality or municipal sewerage corporation for the purpose of assisting in the construction or expansion of a sewage treatment project".

The conditions of the loan were to be at the federal interest rate, not to exceed two-thirds the cost of the works, to be for a term not to exceed 50 years, to be secured by debentures issued by the borrower, to be repayable during that term by equal annual payments of principal and interest and where the works were completed by a certain date to forgive payment of 25 percent of the principal amount of the loan and 25 percent of the interest that had accured on the loan as of the indicated date.

The limits of payments to be made on this program out of the Consolidated Revenue Fund were initially set at two hundred million dollars and extended on several occasions to an eventual $2 billion. The loans applied normally to any works required to collect and treat municipal sewage but did not cover assistance on sewers constructed solely for the direct servicing of properties.

This program known as the Municipal Infrastructure Program operated for eighteen years and terminated at the end of 1978.

It was established as a result of a 1956 study by the Corporation that revealed an inadequate provision for wastewater treatment in many Canadian centres which appeared primarily due to the lack of financial resources as well as the absence of adequate planning. This situation was confirmed in a conference held in 1958 with the Canadian Federation of Mayors and Municipalities, now the Federation of Canadian Municipalities in which the Federation made a strong plea for federal assistance in wastewater control.

All sizes of municipalities benefited from the program with populations ranging from 200 persons to 2,000,000. The size of the loans varied from $3,000 to over $10 million and following the amendments passed in 1961 to the National Housing Act to make it all possible a number of provinces also passed legislation providing for complimentary or supplementary assistance to municipalities.

Toward the end of 1969 after almost a decade of experience in the Program, a review was undertaken by an independent task force that published the Seaden Report in December 1970 noting among its many recommendations for program improvement that:

* the threat posed to national survival from indiscriminate and uncontrolled waste disposal is of national importance and is therefore of a concern to the federal government.

* the federal government should provide leadership in solving the problems of urban environment, including financial help if necessary.

In response to the Seaden Report an Interdepartmental Committee of the Federal Government was established to review its recommendations and discuss them with the provinces with a view to recommending revisions to the Municipal Infrastructure Program through amendments to the National Housing Act which were passed in June 1973, March 1975 and December 1975.

These amendments were highlighted by (11):

"1. Introduction of a second objective of encouraging comprehensive land management and residential development in previously under-developed areas. To help effect this, storm trunk sewer systems and water supply projects were added to sewage treatment projects as being eligible.

2. Provision for a grant in lieu of loan forgiveness for municipalities that chose to finance their projects elsewhere (1/6 of the construction value).

3. Provision for a high cost grant for municipalities where capital costs were excessive (usually smaller and remote communities).

4. Provision of fifty per cent grants to assist in the preparation of regional sewerage/water plans."

The program review also revealed the necessity to work more closely with the provinces and "municipal infrastructure agreements" were negotiated with all the provinces in which the general objectives of the program were annunciated together with an annual budget allocation for the program and a five-year term of the program. As well a joint federal-provincial committee was appointed to administer the program in each province while an "Interdepartmental Committee on Infrastructure" was set up at the federal level to embody the concerns of Environment Canada, Regional and Economic Expansion, Urban Affairs (now disbanded) and Treasury Board in community services. As well the Corporation undertook major research programs with Environment Canada aimed at improving sewage collection and treatment processes.

The Corporation also established a special arrangement with the Department of Regional and Economic Expansion and the National Capital Commission under which projects were funded jointly by their programs and the Municipal Infrastructure Program of the Corporation. Normally all other federal assistance was subtracted from a project cost before calculating the eligible loan or grant under the Corporation's program.

The Municipal Infrastructure Program ran for 18 years and represented one of the most successful endeavours of the federal government in providing co-operative assistance at the "grass roots" level and served as a catalyst in persuading municipalities to implement pollution abatement programs and comprehensive servicing plans.

Almost 1,500 Canadian municipalities comprising about 75 per cent of the nation's population took advantage of the program. All major metropolitan areas received assistance for their treatment facilities through this program - almost $300 million was committed to the Montreal urban community's sewerage program.

Also during the period 1971-1975, additional loan funds of $103 million were provided over and above the program's normal budget to help finance projects in the Great Lakes Basin pursuant to the Canada-U.S. Agreement on the Protection of Water Quality on the Great Leakes.

Almost $2 billion were committed in loans during the life of the program with sewage works accounting for $1.8 billion. Ontario, Quebec and British Columbia were the major beneficiaries although all provinces took advantage of the program.

The grants per capita followed a very similar pattern to the loans. The exception was Alberta where grants per capita were relatively high and loans were low since Alberta maintained a more attractive loans program than that of the Corporation. The total value of grants provided during the program approached $690 million.

The eighteen year Municipal Infrastructure Program was terminated in December 31, 1978 to be replaced by the umbrella Community Services Contribution Program.

6.3 The Neighbourhood Improvement Program (1974-1977)

This program was authorized in June of 1973 and implemented in 1974 as an amendment to the National Housing Act Part III. It authorized CMHC to enter into an agreement with a province to assist a municipality for up to 50 per cent of the cost of:

1) formulating and selecting plans for designated neighbourhood development;

2) acquiring or clearing land for development of open space, community facilities or low income housing;

3) constructing, acquiring or improving neighbourhood recreational and social facilities;

4) developing occupancy and building standards;

5) making loans for commercial improvements;

6) relocating dispossessed individuals;

7) the exposition or public demonstration of the project;

and up to 25 per cent of the cost of:

8) improving municipal and public utility services;

9) acquiring or clearing land that was not capable of being acquired under terms of items 1 through 7.

This was a program in which all provinces but New Brunswick participated. Municipalities with populations under 2,500 received 7.8 per cent of the total federal funding while those with populations from 2,500 to 100,000 received 56.7 per cent, the remainder going to larger communities.

The federal commitment over the life of the program was $199.5 million while the provincial commitment was $108 million and the total municipal contribution $184 million. The program was terminated in 1978 in favour of the Community Services Contribution Program.

6.4 Municipal Incentive Grants Program (1975-1978)

The Municipal Incentive Grants Program was authorized in November 1975 as an amendment to the National Housing Act (56.2) to permit CMHC to encourage the development of medium density housing in Canada by paying a contribution to a municipality for each eligible housing unit constructed within the municipality during the period November 1975 to December 1978.

The amount of the contribution was $1,000 for each eligible housing unit provided provincial assent to the contribution was given, that the units were connected to municipal services and that certain density limitations were met.

The program was terminated in 1978 in favour of the Community Services Contribution Program and operated on a total federal budget of $128 million over the three year period.

6.5 Community Services Contribution Program (1979-1980)

This program replaced the previous three programs under Part VIII.I of the National Housing Act entitled "Community Services" (Clause 54.1). It authorized CMHC under such terms and agreement as entered into with a province, to pay contributions to the province or any local government under the law of the province for the purpose of reimbursing expenditures incurred or paying for the results obtained in the provision, development, extension and improvement of such community services as set out in the agreement.

The program was designed to increase the scope and flexibility of the previous programs and thereby be more responsive to local government needs. It also was designed to reduce administrative overheads by making the provinces responsible for project approval and administration and by ensuring more equitable apportionment of the federal funds among the provinces.

Annual funding for the program was allocated to a province through a formula based on its urban population and municipal taxes. Over the two year life of the program $150 million was allocated in 1979 and $250 million in 1980.

The list of eligible community services included planning and installation of sewage trunk lines and treatment plants, community water supplies, sewer and water site services, social and cultural facilities, community recreational facilities, neighbourhood improvement and conservation, non-profit housing, upgrading and insulation of community facilities, municipal energy from waste plants, and other specially agreed community services.

6.6 Summary of CMHC Programs Conducted under the National Housing Act

These programs as outlined under the previous sections of this Chapter took place over the 20 year span of 1961 through 1980 and represented major contributions to improved urban servicing and pollution control throughout Canada. They catalyzed the focus on the need to conserve on service costs through adequate planning and to recognize the need and hidden benefits of sound water resource management. They also provided a strong interface between the remoteness of the senior governments with the everyday life of the community where the real living in Canada takes place.

The accompanying graph(10) shows the funding for these programs from 1961-1984 (1980 was the last year of new commitment) and shows the tremendous impact of the federal government's withdrawal of support.

The infrastructure improvements purchased for $1.00 in 1971 require in 1984, $2.77. The figures indicated in the graph represent actual dollars spent and are not adjusted for inflation. If indeed this matter of waterworks and sewage works has now become a $2.5 billion industry in new capital invested then the federal government was probably loaning the equivalent of at least 15 per cent of that when the program terminated with 3 per cent provided as grants.

In a letter dated November 27, 1984 to the Inquiry on Federal Water Policy, the current chairman of Canada Mortgage and Housing Corporation, Mr. Ian A. Stewart, noted that the reasons for the government's termination of its assistance programs to municipalities under the National Housing Act in December 31, 1980 were:

1) Consideration of the government's fiscal position and its desire to hold down the deficit while continuing to make funds available for priority programs and new initiatives, especially employment.

2) A fundamental consideration that the federal government should discontinue funding services that jurisdictionally were the responsibility of the provinces and their municipalities.

3) The determination that in terms of job creation money could be better spent elsewhere.

It should also be acknowledged that during this same period CMHC also contributed considerable capital to the assembly of raw land for urban expansion, the acquiring of properties for urban renewal and the provision of services for these lands, all with the approval of the provinces. The value of this capital is not readily forthcoming but is known to be considerable in respect of local water distribution, sewerage and drainage facilities.

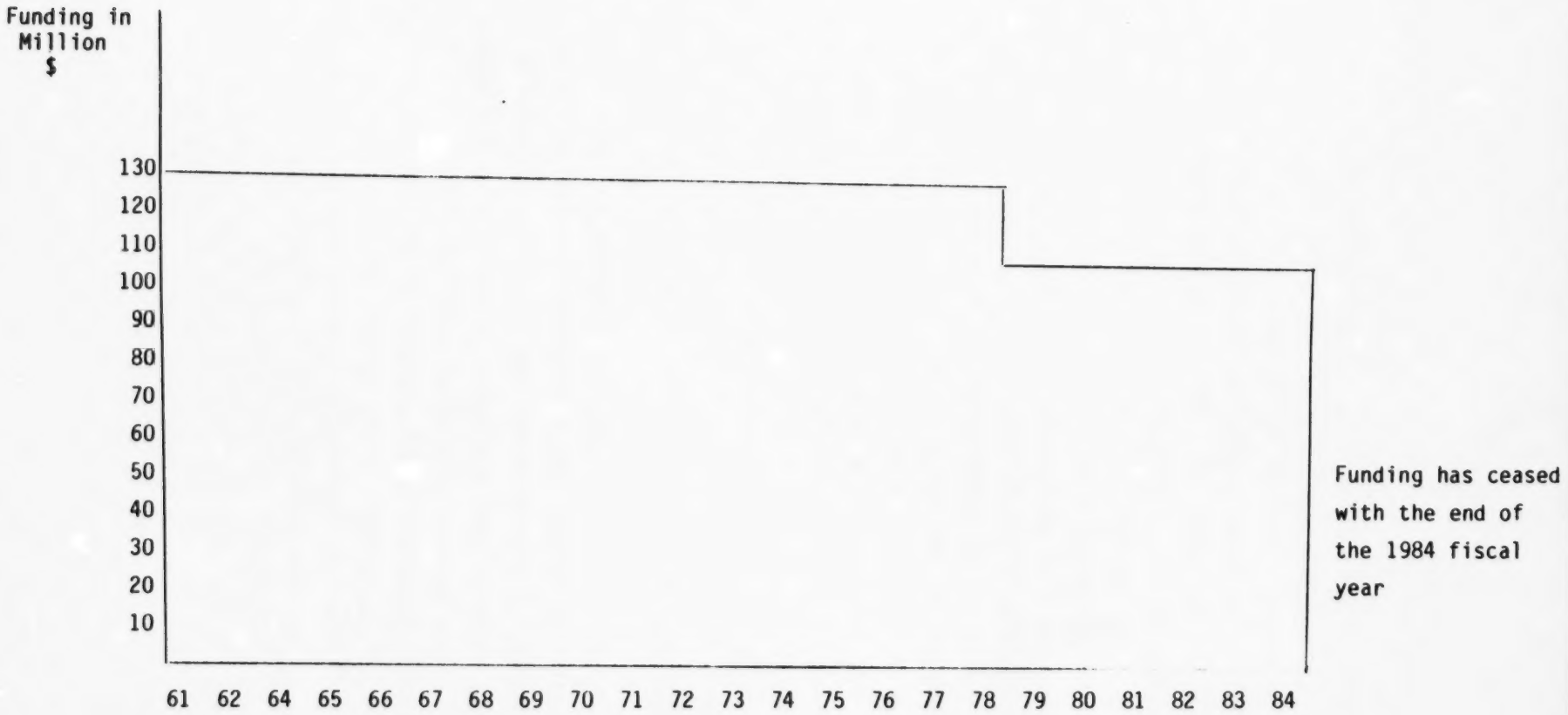
One further comment in respect to the National Housing Act program directed to Municipal Infrastructure can be gleaned from a review of the "Impacts on Land Use of the CMHC Municipal Infrastructure Assistance, 1961 to 1980" prepared by the Lands Directorate of Environment Canada - March 1984 (12).

It outlined major recommendations for the federal government in funding future similar programs and may be summarized as follows:

"1. give preference to servicing land for infill, redevelopment or revitalization where choice exists;

FIGURE 1

AVERAGE ANNUAL LEVELS OF FEDERAL FUNDING FOR
MUNICIPAL INFRASTRUCTURE IN
CURRENT DOLLARS



Included are the following programs:

1)	Municipal Infrastructure Program (1961-1978)	$ 2	Billion
2)	Neighbourhood Improvement Program (1974-1977)	$199.5	Million
3)	Municipal Incentive Grant Program (1975-1978)	$128	Million
4)	Community Services Contribution Program (1979-1980)	$400	Million
5)	Urban Transportation Assistance Program (1978-1984)	$230	Million

Source: Federation of Canadian Municipalities, Technical Committee. Canada's Urban Infrastructure, Appendix E: Finan and Knight, Federal Support for Municipal Infrastructure in Canada. June, 1984.

2. require evidence of the approval and implementation of local and/or regional land use plans;

3. require that, to the extent possible, such plans support compact development and protect high capability resource lands;

4. during project screening ensure that land use concerns under federal policy on land use are considered; and

5. in program delivery, allow flexibility in terms of eligible areas, servicing technologies."

It is also noted that while the experience had been mixed, the program could be regarded as a potentially positive instrument for reducing water pollution and encouraging and facilitating contiguous, efficient and compact urban development at an appropriate rate.

6.7 Other Arrangements

The federal government conducted a Winter Works Subsidy Program through Public Works Canada commencing in the mid 60's and intermittently thereafter through the Department of Regional and Economic Expansion to support the construction of municipal works including water and sewage wroks during the winter months. The emphasis of this program was to encourage winter work to reduce unemployment at the local level during the colder periods of the year.

Significant grants and loans were provided by the Department of Regional and Economic Expansion commencing with its inception in 1968 and later carried on to date by its successors the Department of Regional Industrial Expansion and the recently dissolved Ministry of State for Economic Recovery and Development to assist municipalities through their provinces in expanding and improving municipal infrastructure including waterworks and wastewater control systems.

General Development Agreements were negotiated with the provinces and subsidiary agreements for water treatment and wastewater systems were concluded that provided significant assistance for the extension of waterworks facilities in Saint John, N.B., waterworks and intercepting sewers in the City of Halifax and assistance for advance water treatment in the City of Regina as examples. Many communities in all provinces benefited from these programs. Indeed reference was made to the very large investment made in municipal water supply (and sewage works) infrastructure, particularly over the period 1970 to 1984, by public and private sources in the Atlantic provinces. The consumers, the municipalities, the provinces but especially the federal government (DREE and CMHC) all made significant contributions(7).

Some of these DREE and DRIE agreements combined their grants and loans with the Municipal Infrastructure Program and later the Community Services Contribution Program of CMHC while some did not.

Also agreements that have been concluded through Regional and Economic Expansion and Regional Industrial Expansion have provided loans under the terms of the Agricultural and Rural Development Act (ARDA) that related to the provision of municipal services, especially drainage.

Special Area Arrangements were negotiated following the termination of Community Services Contribution Program for the provision of additional funds exclusive of those provided under that program and its predecessor program for the provision of intercepting sewers and sewage treatment for the Montreal Urban Community. Under a federal/provincial agreement the funds provided were $200,000,000 of which 60 per cent was federal grant.

Also the Ottawa Carleton Region and the Outaouais Regional Corporation of the National Capital Area were provided special arrangements for wastewater assistance in 1970 and 1972 respectively that exceeded the benefits under the Municipal Infrastructure Program of CMHC in order to compensate each region for their costs in the light of the federal government's grant-in-lieu of taxes.

The Prairie Farm Rehabilitation Administration carries out certain special programs for prairie municipalities that are unique in Canada but can be described as follows:

1) Agricultural Services Centres Agreements with Manitoba and Saskatchewan under the Department of Regional Economic Expansion commencing in 1972 and now terminated.

2) Rural Water Development Program in Manitoba and Saskatchewan.

Under the former program, the PFRA undertook with the provinces to plan, design and construct in such arrangements as were necessary the provision of water supply and/or waste disposal facilities for certain municipal centres in the provinces with the federal government contributing 50 per cent of the cost and loaning, 50 per cent of the cost to the province. The cost was defined between the federal government and the Agriculture Centre on a project to project basis.

Under the later program which is still in efect PFRA will provide technical and financial assistance to rural agricultural communities in Saskatchewan and Manitoba having a population of 300 or less for investigating water sources, designing source development programs, drilling for groundwater and constructing the needed facilities.

PFRA will arrange for the construction, provide full contract control and pay 100 per cent of the cost of approved project.

Fifty per cent of the development cost is recovered from the applicant.

6.8 Canada-Ontario Agreement on Great Lakes Water Quality (13) - July 12, 1982

The purpose of the current agreement soon to be renegotiated is to renew and strengthen co-operation between Canada and Ontario in meeting the obligations assumed by Canada under the Revised U.S.A.-Canada Agreement on Great Lake Water Quality (November 22, 1978). It also provides for the cost sharing of specific programs which the Province of Ontario will undertake to assist Canada in meeting these obligations.

Both parties are required to contribute equally to the costs of the various programs with the maximum annual combined contribution not to exceed $2.4 million subject to review and modification as required.

The program requires Ontario to:

1) compel municipalities to treat wastewaters to certain specific objectives,

2) require industries to pretreat wastewaters discharging to municipal systems,

3) develop and implement reasonable programs for reducing pollution from storm, sanitary and combined sewer discharges,

4) require industries discharging waste effluents directly to the Great Lakes system to meet certain effluent standards,

5) substantially eliminate discharge of persistent toxic substances into the Great Lakes system,

6) control thermal discharges,

7) minimize adverse environmental impacts of water intakes with respect to damage to fish,

8) with Canada, impose controls on radioactive discharges into the Great Lakes system.

The Agreement provides special arrangements for preparing an annual inventory of abatement requirements, special programs on eutrophication control through phosphorous reduction, pollution control on shipping activities, control of pollution from dredging activities, pollution by oil and hazardous wastes from on-shore and off-shore facilities and specific measures for the control of pollution attributable to land related activities (PLUARG) including pest control products, animal husbandry operations, liquid and solid wastes and soil erosion.

The Agreement also provides for contingency plans, surveillance and research. It serves as a model arrangement for the joint sharing of

obligations, responsibilities, undertakings and costs related to a mutually agreed program and could be employed as an example for specific accords with other provinces since it obtains its authority through the Canada Water Act.

7. ALTERNATIVE FINANCING SCHEMES FOR MUNICIPAL INFRASTRUCTURE

The annual fixed charges for the repayment of capital and interest thereon and the annual operating charges for maintaining and "running" a municipal waterworks or wastewater control system are normally paid as a charge or surcharge on the water consumed by the various users plus some levy on the rateable assessment of properties that benefit as non-users from these services.

With appropriate rate structures, user fees can be made fair and equitable to encourage efficient use of available facilities and conservation of the supply and its discharge. The landmark report of a Joint Committee of the American Society of Civil Engineers and the American Bar Association in 1951 entitled "Fundamental Considerations in Rate and Rate Structure for Water and Sewage Works" established the fundamental principle that:

> "The needed total revenues of waterworks and wastewater systems shall be contributed by users and non-users (or by users and properties) for whose use, need and benefit the facilities of the system are provided, approximately in proportion to the cost of providing the use and benefits of the facilities."

Today this fundamental is preserved in the Water Rates Manual of the American Water Works Association and a joint publication of the American

Public Works Association, the American Society of Civil Engineers and the Water Pollution Control Federtion entitled "Financing and Charges for Wastewater Systems".

Municipalities may also levy impost charges on subdivisions and redevelopment to pay the cost of a significant portion of the expansion of waterworks or sewage works required to make provision for the servicing of this new demand.

Capital investment in municipal infrastructure is traditionally financed by borrowing through municipal bond issues considered as a general obligation on the rateable assessment of the municipality. Revenue bonds currently are not permitted by our provinces as a source of capital for their municipalities. With high rates of interest and of inflation, the availability of capital to the average municipality has been curtailed especially to smaller communities.

To circumvent this problem, a number of American states as well as the United States Government have or are considering the establishment of Infrastructure Development Banks that provide a rotating fund at favourable interest rates based on capitalized bond issues, government appropriations, revenues and private investment on which municipalities can draw to undertaken expansion, modernization or rehabilitation of waterworks and wastewater control infrastructure.

Here in Canada, the usual practice has been to catalyze new municipal levels of spending such as the institution of pollution control in 1961 with a combination of grants and loans from the senior governments that may represent up to 50 per cent from those combined sources of the required capital spending but do not assist in the cost of operation and maintenance.

8. CONCLUSIONS

Never in the history of our country has the need for improved and sustained environmental service in the urban and community fabric of Canada been more obvious.

The period of sustained high interest rates, inflation and deteriorated economic activity has forced municipal governments to cut back and to restrain spending on an infrastructure in waterworks that now is exceeding 40 years in age on a weighted national basis and 30 years or more in sewage works(6).

The need to mount a sustained and continuous program on rehabilitation and where necessary replacement of this infrastructure has been widely demonstrated in Europe, North America and specifically in Canada (6,7, and 8).

Compounding this need is the fact that there are indications that numerous Canadian municipalities that do not now have water treatment require some form of treatment to ensure continuing safe water to their customers in the face of a growing reduction in raw water quality, surface or subsurface. Some who have treatment now may no longer find it adequate in the face of that deteriorating raw water quality.

Similarly some municipalities have yet to construct a sewage treatment facility to meet their commitments to maintaining receiving water standards acceptable to other users while some must upgrade existing facilities to meet these same commitments.

The issue of pollution from urban runoff has grown severe both from combined sewer overflows during rainfall as well as storm runoff from separate storm sewers. This pollution threatens the use of receiving waters by a variety of users and indeed if uncontrolled endangers the basic ecosystem in many areas.

These basic needs are creating real pressure on municipal finance and user charges and although these traditional vehicles must bear the brunt of the additional level of service now required, some level of senior government assistance is now necessary to catalyze action and bridge the initial impact of increased spending.

The urban community serves as the economic ethos of the Canadian economy so that a reliable infrastructure is paramount to the competitive position of Canada's industry and commerce as well as its healthy state. More than $100 billion would be required to replace our current municipal infrastructure in waterworks and sewerage and wastewater control and yet the continuous annual expenditure of less than one per cent of that value for approved rehabilitation program will sustain it and avoid the need of their replacement at a depressingly early date.

Finally (6) there is the matter of high unemployment currently prevailing in Canada. Works related to the maintenance, repair, rebuilding and necessary expansion of urban infrastructure such as waterworks and sewage works are highly labour intensive involving skilled and unskilled labour in more than 2,500 communities across Canada. There is an excellent opportunity at this time to employ many people for this essential re-construction and upgrading of municipal environmentally-related infra-structure. At the same time advantage can be taken by municipalities of the very competitive prices that exist now for contract work. The combination of the foregoing can contribute to the economic recovery of Canada with only a modest federal financial contribution with matching provincial assistance. The local users would still bear the major expense of the needed investment and all the increased operating costs. In addition, they would bear the continued cost of expansion of service since it is intended that senior government assistance be required only to upgrade and rehabilitate but not to subsidize expansion of capacity.

Arguments have been raised that federal spending must be constrained to reduce the deficit and that federal monies should be directed to job creation. But this is a very significant job creation program and at the "grass roots" level that should be undertaken with provincial cost sharing to sustain the economic health of our national economy.

Recognition of the federal participation can be gained through the approach of the original Municipal Infrastructure Program and the use of joint federal-provincial committees. This was the most successful formula of all past programs and the best received. It combined grant with borrowing and required the user to pay the major cost both fixed and operating.

Programs should, however, only be undertaken if they:

1) Can satisfy benefit-cost analyses that provide maximum benefit for the least total lifecycle costs.

2) Meet value analyses examination by independent professional study groups.

3) Include for provision of adequately qualified personnel for their continuous operation.

4) If the benefiting municipalities agree to commit their water supply systems to complete metering of customers within a reasonable time span (unless sound contrary argument can be provided).

5) If the same municipalities agree to enter into approved un-accounted for water reduction programs.

The priorities of federal government spending especially as they relate to the decrease of unemployment, economic recovery, and the preservation of a major investment should rank municipal infrastructure in waterworks and wastewater control high on the agenda, especially since they preserve the health of our people and the protection of the nation's water resources.

This is especially true in relation to the significant numbers of our population residing in small communities especially native people, which do not yet have access to a safe water supply or an approved sanitation system.

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